BIOLOGY

The following are meant as *guidelines*. The instructor is free to re-interpret and re-order the material**.**

BIO-101: CELL BIOLOGY (3 Credits, 36 hrs)

	No of Lectures
1. Reductionism vs. holistic view of living system Debate on the definition of Life:- Molecular view : Koshland's concept – PICERAS	1
Living vs. Non-living biological entities: virus, viroids and prions	1
2. Cell as the unit of life. Development of cell theory: Cell types : prokaryotes vs. eukaryotes; from single cell to multi-cellular organism; Prokaryotic cells: Structure, cell-walls and related molecules, outer membrane, flagella, motivity, cell inclusion endospores, gas vesicles, capsules, slime layers	2
Plant cell wall, Animal cell membrane, Structure of the cell membrane, Fluid mosaic model, Function of plasma membrane, diffusion, osmosis, membrane transport, ion channels and electrical properties	1
Cell architecture, cyto-skeletal components, microtubules and microfilaments, motility and motor motions, actomyosin complex	1
Extra-cellular matrix: Cell nucleus: Chromatin structure, nucleolus, nucleoplasm	2
Endomembrane system: endoplasmic reticulum, Golgi complex, endosomes, lysosomes	2
Cell signaling :- messengers and receptors	2
3. Molecules of life: Water, function of sugars in biosystem: mono-, di-, polysaccharides, storage function of lipids fatty acids, phospho-lipids, steroids, alkoids, liposomes, micelles, planar bilayer, spherical bilayer, vesicles, functions of proteins – amino acids, peptide bonds, Ramachandran plot. Glycoproteins, Glycolipids Primary, secondary, tertiary, quaternary structure: Hb as model, Enzymes: Classification, kinetics, Nucleic acids: Structure of DNA & RNA, DNA replication, Transcription, Translation, Hormones, Antibodies Metalloenzyme, multi-enzyme complex	18
4. Energy Transduction and Bioenergetics: Mitochondria, ATP, Chemiosomes, ATPase, Gap junctions Chloroplast – photosynthetic electron transport, Calvin cycle	3
5. Anti-reductionism: Cell division: Mitosis, meiosis and cytokinetics, animal and yeast cell division, cell cycle control, programmed cell death	3

BIO-102: GENETICS (3 Credits, 36 hrs)

	No of. Lectures
1. Principles, Model system and Nomenclature Mendel's laws, chromosomal basis of inheritance, Definition of genes, alleles, mutants, Sex linkages; Haploid vs. diploid genetics , Tetrad analysis	3
2. Genetic linkage Building genetic map based on recombination frequency, ordering genes by three factor crosses,deletion mapping	3
3. Complementation: Complementation tests, allelism, verification of linkage mapping, genetic interactions of n-linked loci, penetrance, expressivity	2
4. Molecular basis of phenotype Genetics as a study of how proteins interact, fold, function, Nonsense suppression of null alleles, loss of functional alleles, conditional alleles	2
5. Mutagenesis: Mutagen, Chemical basis	3
6. Microbial genetics: Transformation, conjugation, genetic mapping, recombination, Plasmids, transposable elements in prokaryotes and eukaryotes, Phage lambda : lysis vs. lysogeny, Campbell's model of integration, Site specific recombination, specialized transduction, induction, Pi-transduction, Lac-operon, Ara-operon.	10
7. Recombinant, DNA Technology : Restriction Endonucleases, Genetic cloning, techniques, Sequencing, PCR, DNA finger-printing	4
8. Human genetics: Non-mendelian inheritance, Diseases loci and pedigrees, Mapping with PNA markers, simple vs. complex traits, Dynamic / imprinting, modes for specific mechanism of imprinting	
9. Genomics	9
	36

B201: SYSTEMS BIOLOGY (3 Credits, 36 hrs)

	No of Lectures
1. Comparative organization : various model systems from simple to complex organization, Examples : E. Coli, yeasts, Dictyostelium, C. elegans, Drosophila, Zebra fish, Xenopus laevis, mouse and Arabidopsis	1
2. Developmental Biology : Gametes, fertilization, early development, cell-cell interaction, cell communication, embryonic induction, cell differentiation, abnormal differentiation and neoplasia and late development including organogenesis.	8
3. Ageing: classical theories and modern concepts including telomeres, shortening hypothesis	2

4.	Defense system: Innate vs acquired immune response, components and immune development and function	4
5.	Chronobiology: Definition, circadian rhythms and organization, circadian clocks, functional aspects	2
6.	Social organization: Species interaction, community structure and function with reference to ants and honey bees	4
7.	Gene expression network	4
8	Chaos	2

BIO-202: EVOLUTIONARY BIOLOGY (3 Credits, 36 hrs of contact)

		No. of Lectures
1.	History & Development of Evolutionary thought	2
2.	Neodarwinism: Spontaneous mutation debate, natural selection – types of selection, levels of selection, mutations and rates of mutations	2
3.	Population genetics: Mutation selection balance Hardy-Weinberg equilibrium, selection on dominant and recessive traits, heterozygous advantage; Polymorphism and genetic diversity; Genetic drift and allelic fixation; Linkage dis-equilibrium	6
4.	Kin selection, sociobiology, evolution of cooperation	4
5.	Evolution and stability of sex and sexual selection	3
6.	Speciation, mechanisms of speciation, origins and stability of biological diversity	3
7.	Co-evolution and red queen effect, host parasite and predator prey co-evolution	3
8.	Neutral evolution and molecular clocks, molecular distances and phylogeny, Molecular evolution synonymous and non-synonymous substutions, Ka / Ks measurements, protein polymorphism, protein gene duplication, horizontal transfer, genomic evolutions (hemoglobin, cytochrome oxidase) (nuclear vs. mitochondrial)	13

Biology: Third year course titles

Semester – V	***Semester – VI***
1.Microbiology & Virology	8. Infectious diseases and Epidemiology
2. Immunology	9. Genetic Engineering
3.Metabolism and Regulation	10.Endocrinology

4.Molecular Biology	11.Biodiversity and Biological systematics
5.Biometry	12.Chronobiology
6.Human Physiology	13. Environment and Toxicology
7. Laboratory	14. Laboratory
(TOTAL 24 credits)	***(TOTAL 24 credits)***

Biology: Fourth year course titles

Semester – VII	***Semester – VIII***
1. Developmental Biology	1. Bioengineering
2. Neurobiology	2. Drug development
3. Animal behavior	3.Plant Biotechnology
4. Structural Biology	4. Secondary Metabolites and Natural Product Chemistry
5. Entomology	5. Bioinformatics and MolecularModeling
6. Biochemical Regulation	6. Nano-biotechnology
7. Laboratory	7. Modeling Biological systems
(TOTAL 24 credits)	8. Laboratory.
	(TOTAL 24 credits)

Biology: Fifth year program

Research/ training Project work for both semesters of the 5th year with two supplementary and/or optional courses each semester. Students will be required to write a Project Thesis. Total No. of Credits in the 5th Year is 48.

For selected students, the program in the fifth year may initiate research work towards a subsequent Ph D degree.

Practicals

Biology - Semester 1

BIO-121: Cell Biology

S.No	Experiments	Time
1	(a) Aquaintance of different cells, organisms and virus morphology: Use of microscopy and electron microscope with ready-made slides and live preparation of samples.	3P, 9 hrs
	(b) Study of Cell structure and measurement	
	Reference to Theory topics (1, 2.1), Physics input: Optics	

2	(a) Study of Diffusion of small molecules (pigments, stains and salts): Cell uptake and Phagocytosis, RBC lysis (osmotic measurements) Refer to Theory topic 2.2	2P, 6 hrs
	(b) EM observation of cell structures and organelles	
3	Estimation of lipids (iodine method), carbohydrates (DNSA), proteins (Bradford method) and enzyme assay (Amylase)	4P, 12 hrs
	Ref: Theory topic 2.5, Chemistry input	
4.	(a) Sub-cellular fractionation	3P, 9 hrs
	(b) and (c) Identification of blood cell types (Giemsa staining and microscopy)	
5	(a) and (b) Mitosis (onion root tip preparation), readymade slides and preparation of samples	2P, 6 hrs
	(c) Cell viability by Trypan blue staining	

Biology: Semester 2

BIO-122: Genetics

S.No	Experiments	Time
1	Drosophila chromosome preparation (salivary gland)	1P, 3 hrs
2	Drosophila development, sexing and crosses	3P, 9 hrs
3	(a) Bacterial culture and liquid and plates,	4P, 12 hrs
	(b) mutation studies (UV)	
4	Plasmid preparation (Gm +, Gm -) and transformation: Agarose gel electrophoresis, UV spectroscopy	3P, 9 hrs
5	Lambda lysis	1P, 3 hrs

Biology- 3 Semester

BIO-221: Biochemistry

S.No	Experiments	Time
1	Protein extraction, purification and analysis: Ion exchange, gel filtration, affinity, SDS-PAGE, Enzyme activity	8P, 24 hrs
2	Liposome preparation and analysis, TLC	4P, 12 hrs
3	Nucleic acid extraction and analysis: genomic DNA (plant and animal)	4P, 12 hrs
4	Enzyme kinetics	3P, 9 hrs

Biology- Semester 4

BIO-222: Systems Biology

S.No	Experiments	Time
1	Yeast culture: Dimorphism, C. elegans, Arabidopsis, Frog and Chick: Isolation and cultures	4P, 12 hrs
2	Developmental studies: Chick, Frog, Drosophila, germination and root development	4P, 12 hrs
3	Immunology: Blood group typing	2P, 6 hrs